Tidal glaciers retreat – loss of specific marine habitat in Arctic

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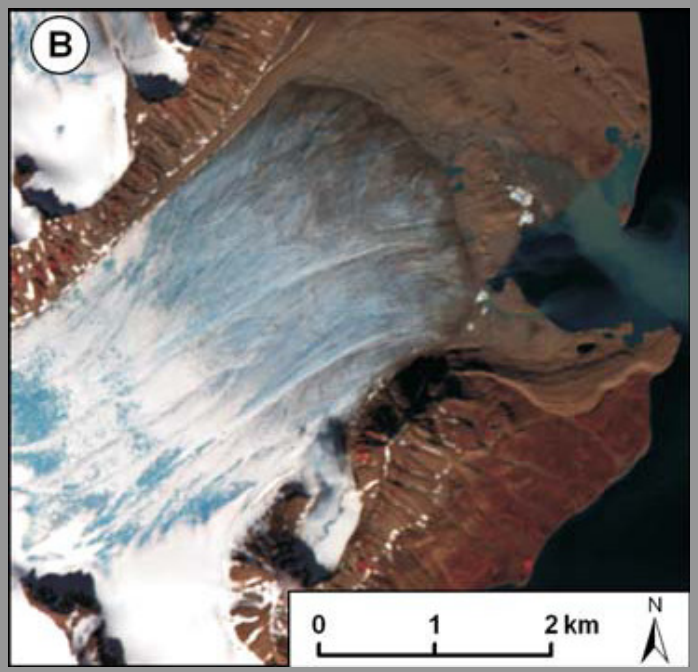
ASSW Kraków 2013 – Science Symposium, session 3.5

Length of tide water glaciers cliffs on Svalbard - 1028km
Annual calving loss 5 to 8 km3 of freshwater/ year
14 tidal glaciers recently terminated on land

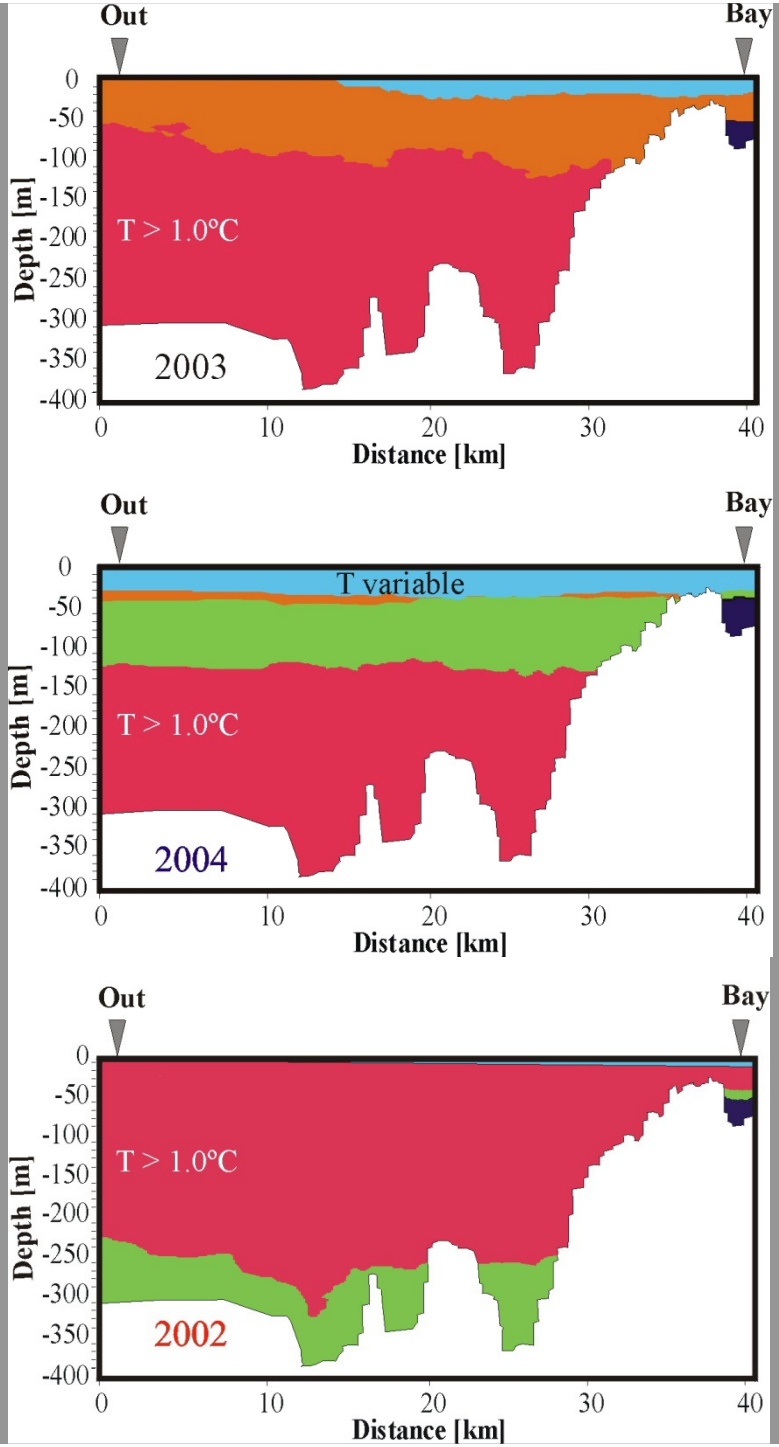
Błaszczyk et al.. 2009



Can tidal glacier serve as Noah's arc to carry the cold water species through the warming period ?

Tidal glaciers – habitat forming role

Iceberg scouring, coarse material sedimentation

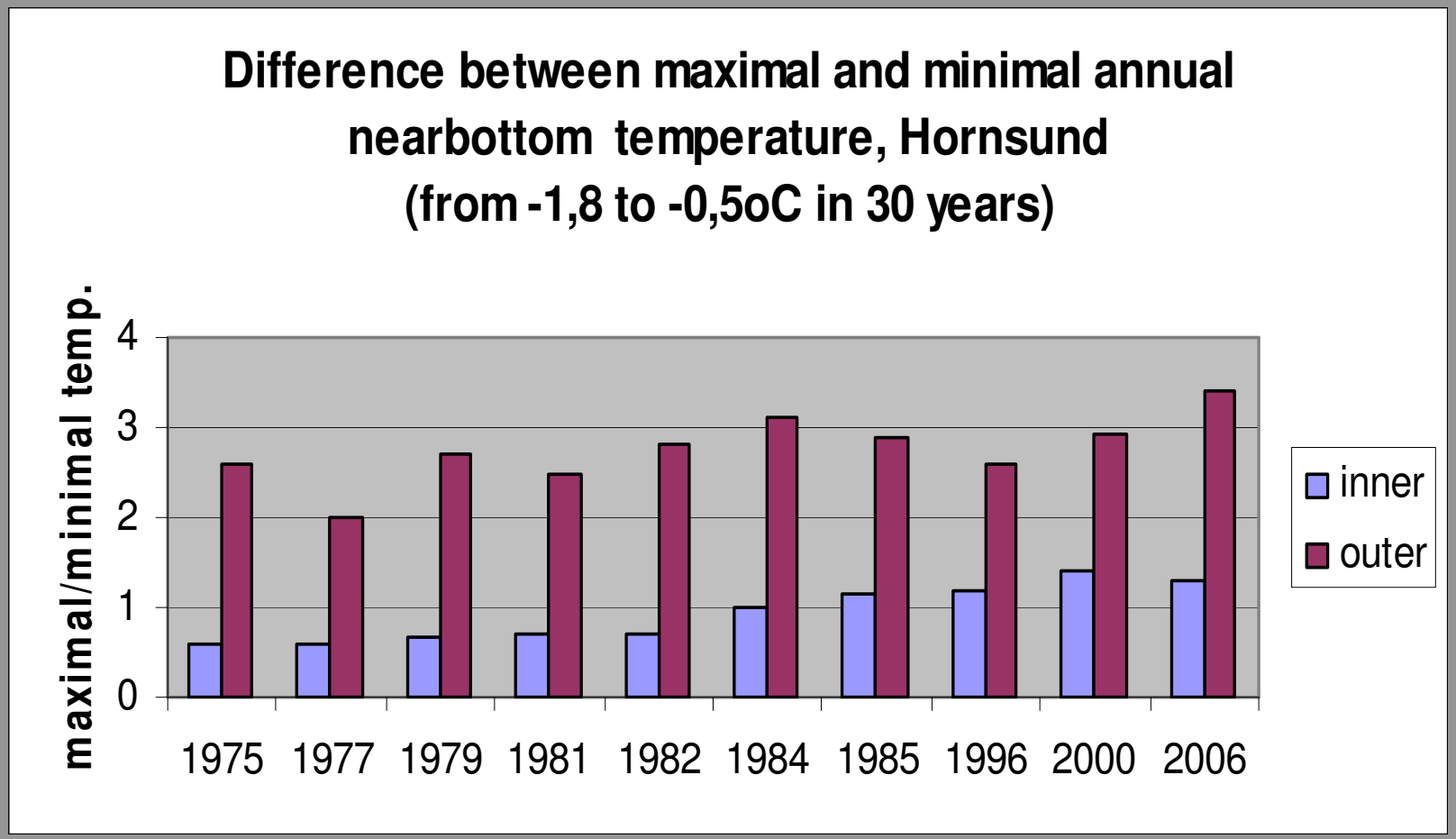


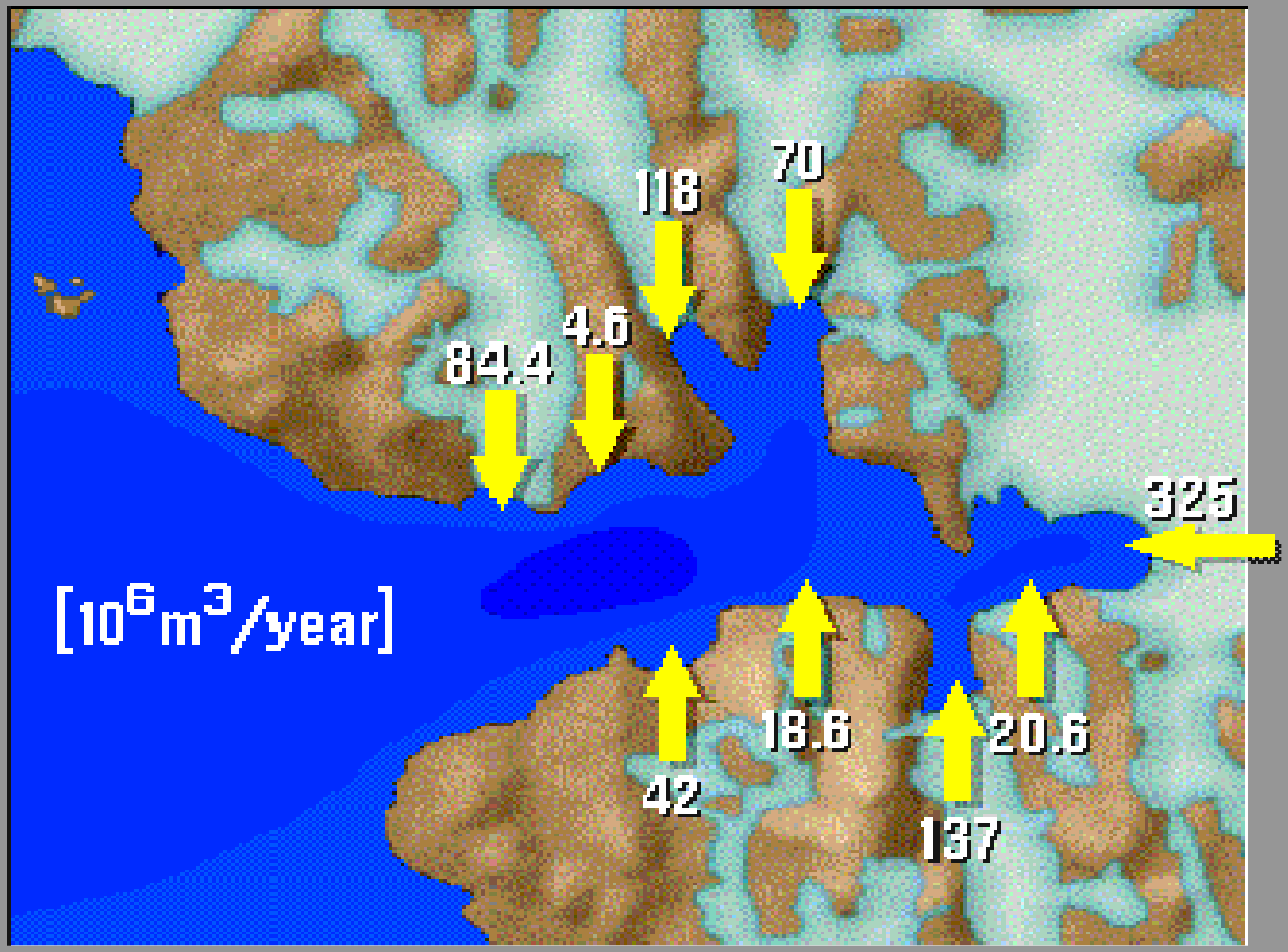
Kongsfjorden

SW		T variable S < 34.0
IW		T variable S 34.0-34.65
WCW		T < -0.5°C S 34.4-35.0
LOC		T -0.5 - 1.0°C S 34.3-34.85
AW		T > 1.0°C S > 34.65

SW-Surface Waters, IW-Intermediate Waters, WCW-Winter Cooled Water,
LOC-Local Fjord Water, AW-Atlantic Water
(IOPAS, Marine Hydrology Dept., Cottier et al. 2006; Walkusz et al. submitted)

Cold, dense water formation and persistence





Freshwater outflow from glaciers in Hornsund

– J. Jania in Weslawski et al. 1995

Physical drivers –biological response

- **Light** – autotrophes to mixo and heterotrophes
- **Suspensions** – filtrators, microbes,
- **Sedimentation** - sesile benthos
- **Salinity** – stenohalyne organisms, necrophages
- **Temperature** – stenothermic organisms
- **Ice scouring** – sesile benthos, fragile species
- **Hydrodynamics** – plankton, top predators

Water- column **bacteria** are most abundant in near-glacial area (combined effect of organic and mineral particles abundance ?)

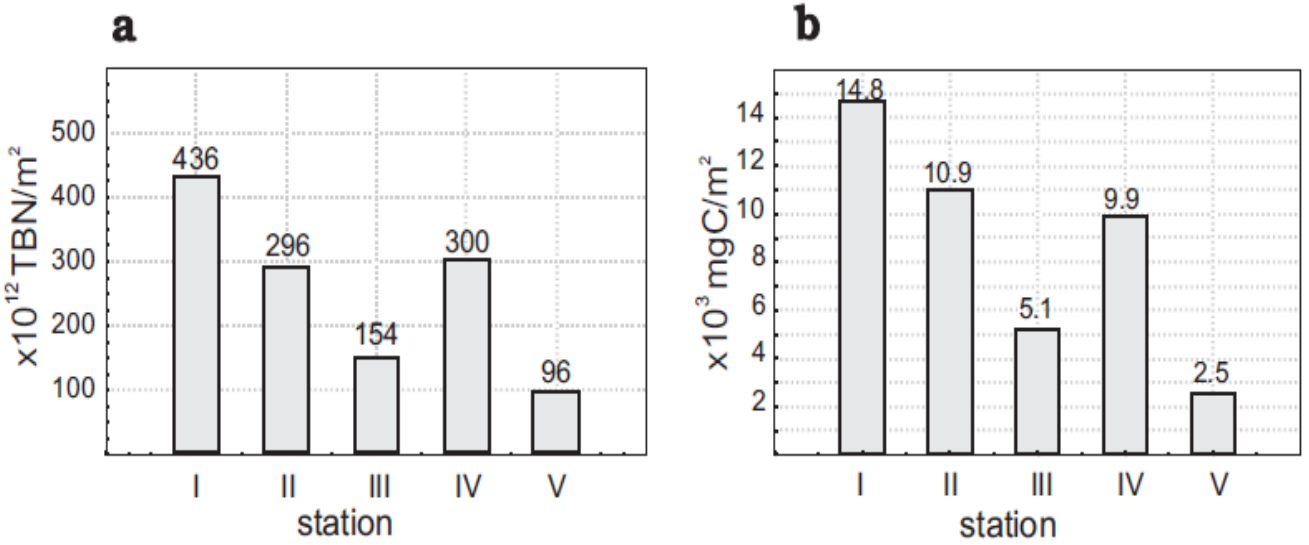
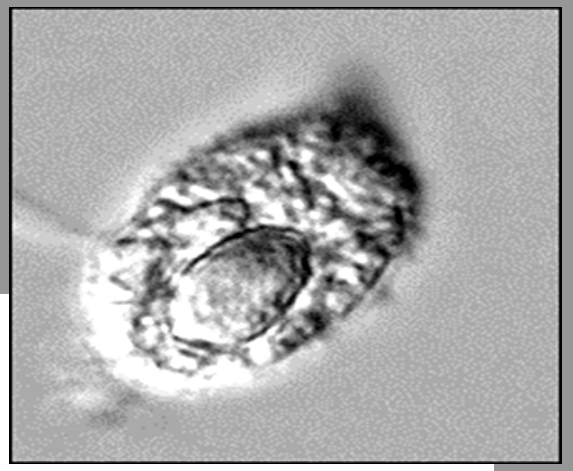


Fig. 2. a – total bacterial number (TNB), b – biomass (BB) at stations.

Glacial bays have distinct **microplankton** composition with prevalence of small mixo and heterotrophes (Wiktor and Piwosz 2005)



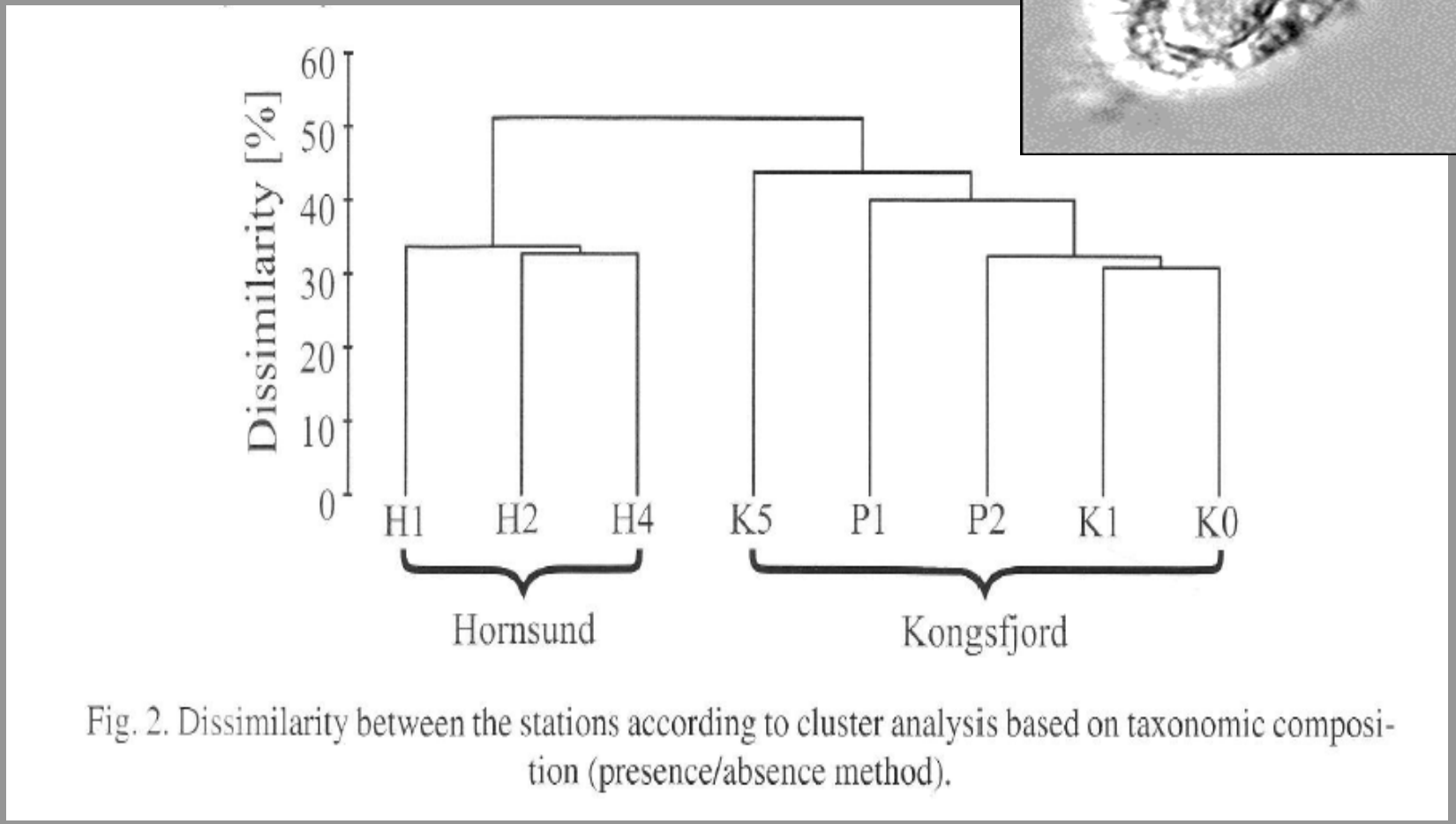
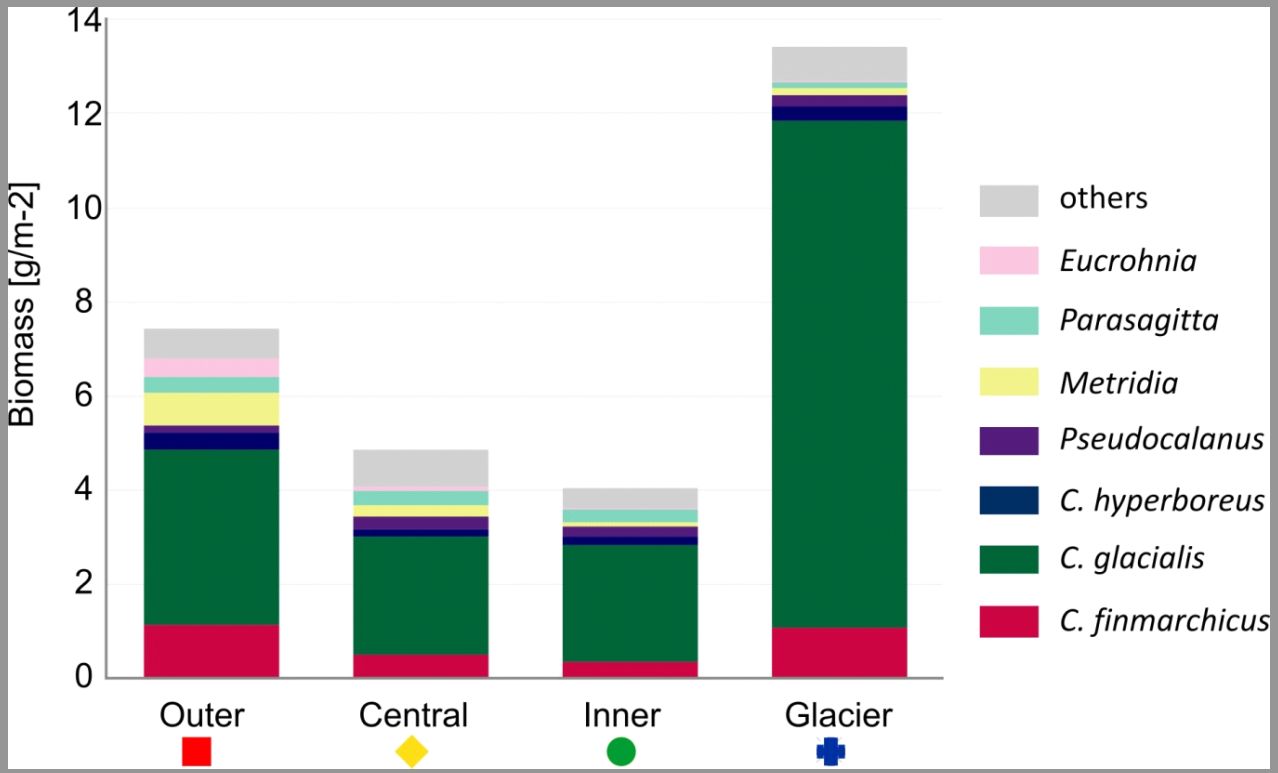
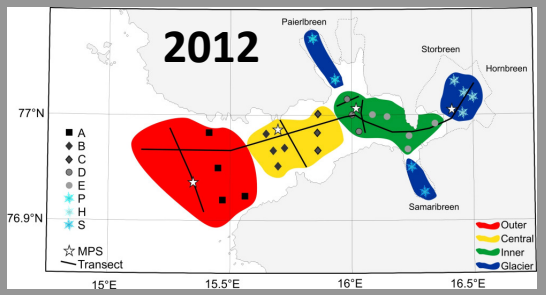


Fig. 2. Dissimilarity between the stations according to cluster analysis based on taxonomic composition (presence/absence method).

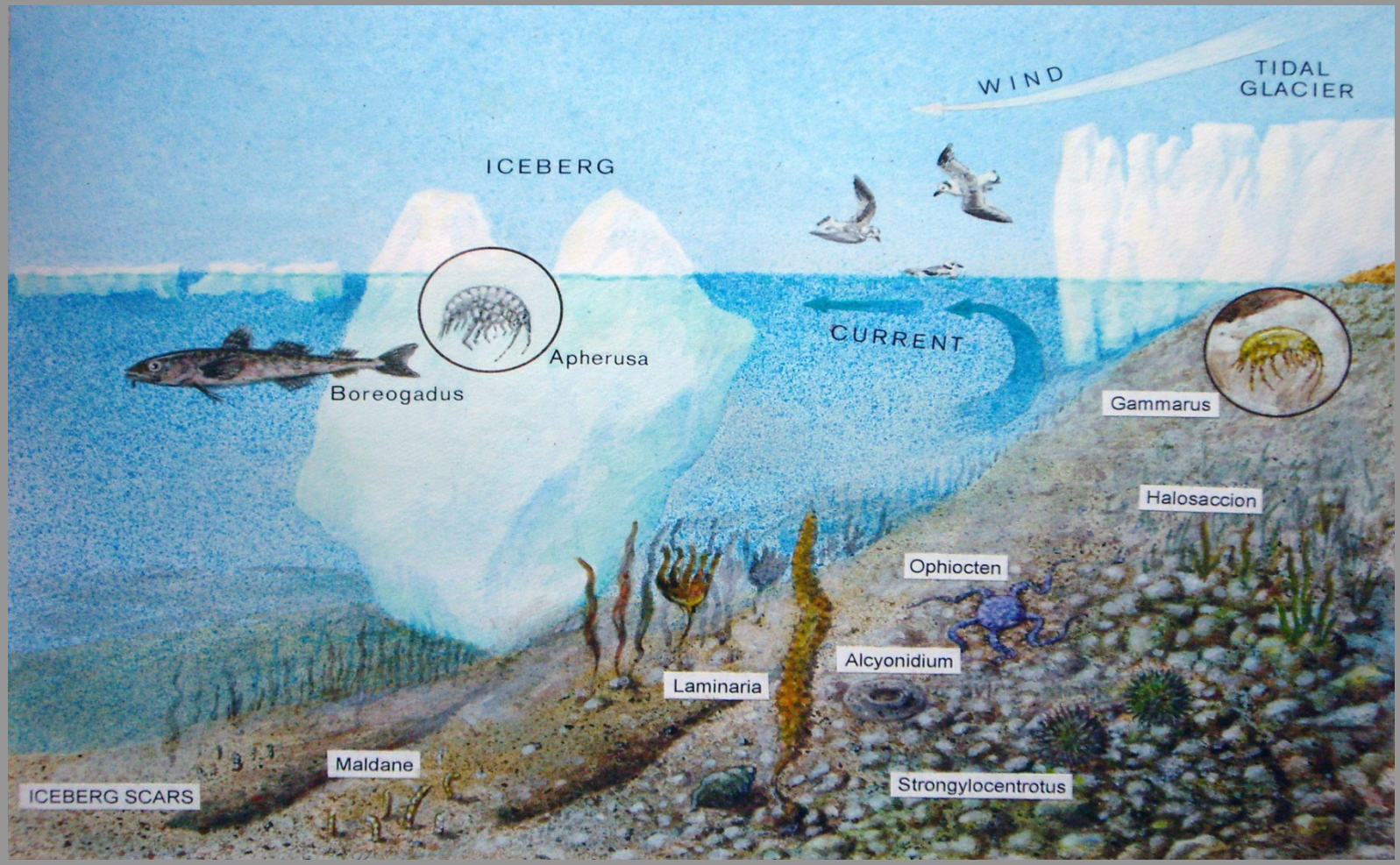
Mesozooplankton
Biomass and Composition in net samples



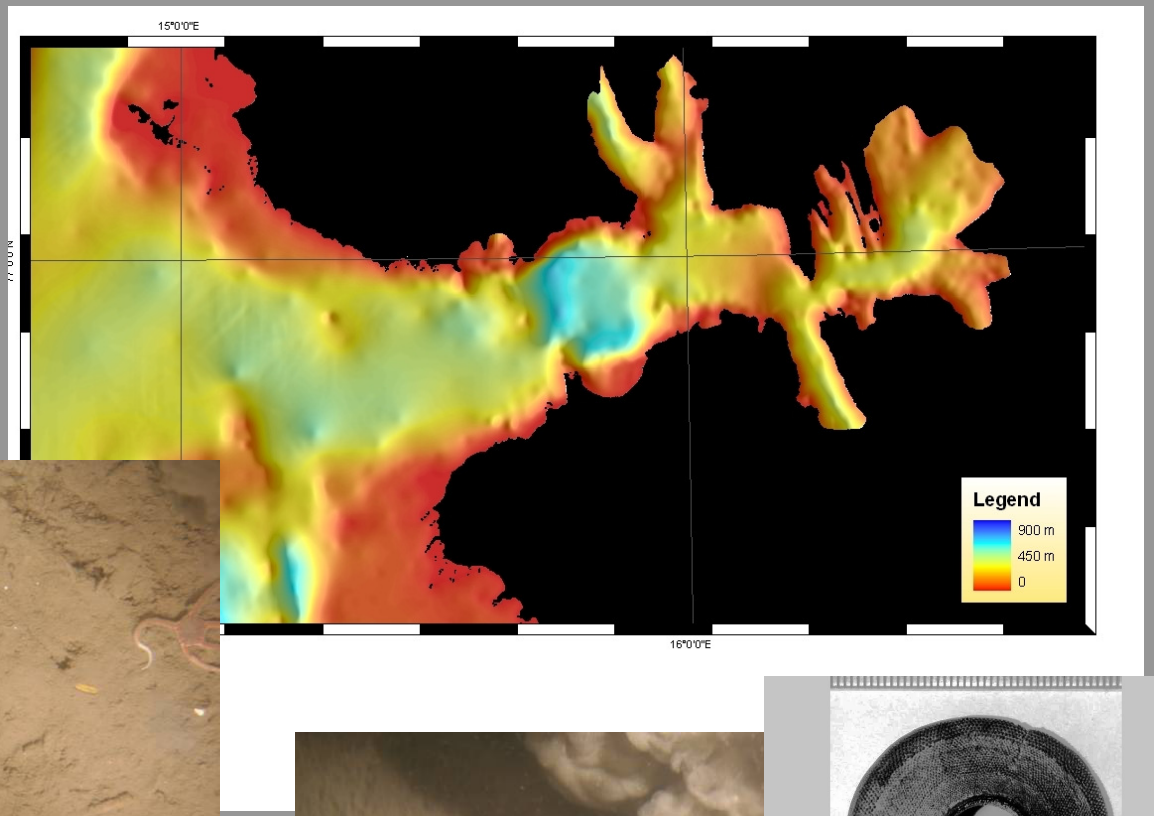


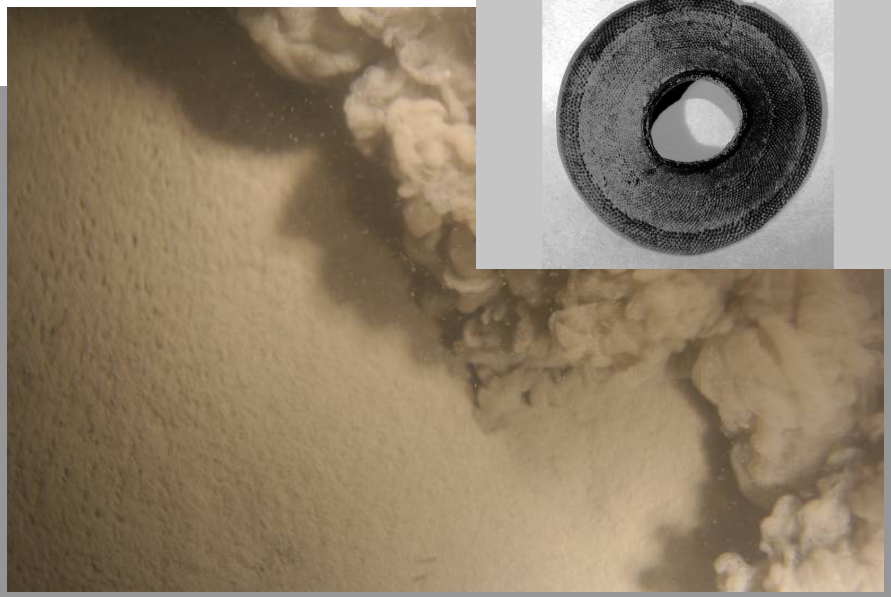
Emilia Trudnowska et al.. 2013

Macroplankton sinks down and is concentrated near the glacier avoiding freshwater outflow
– Węslawski et al. 2000.



BENTHOS





Alcyonidium disciformae – unique bryozoan

Macrobenthos biomass – Hornsund,

Gorlich et al. 1989

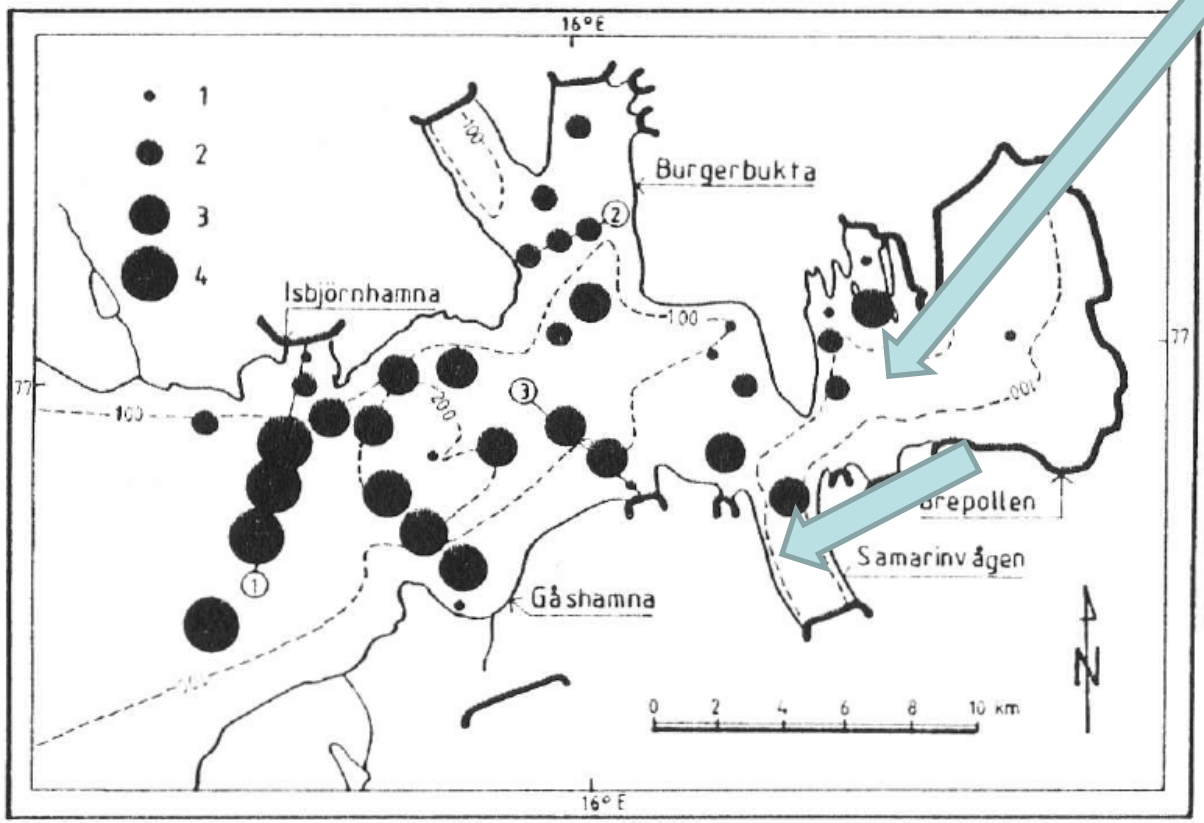
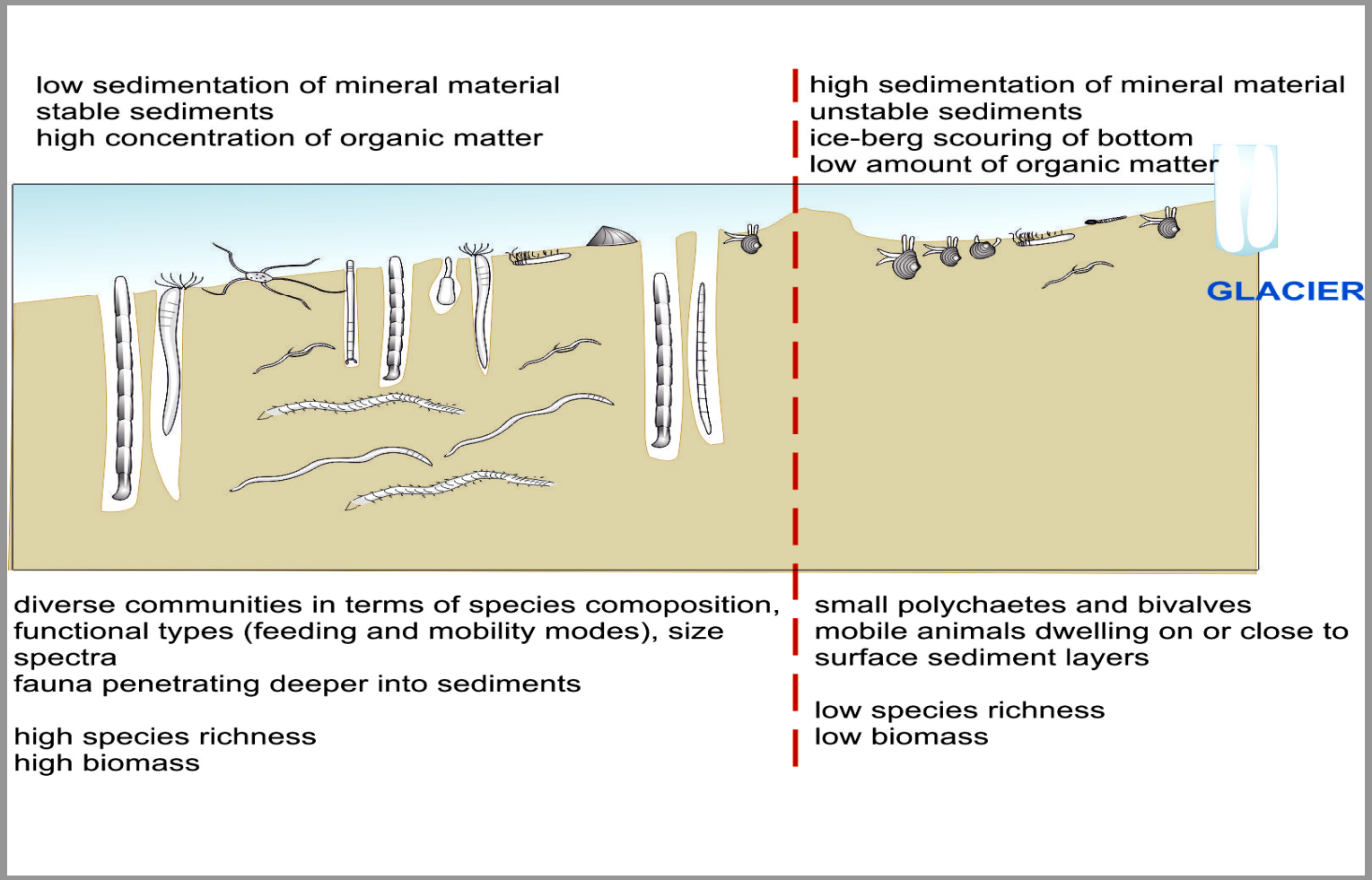


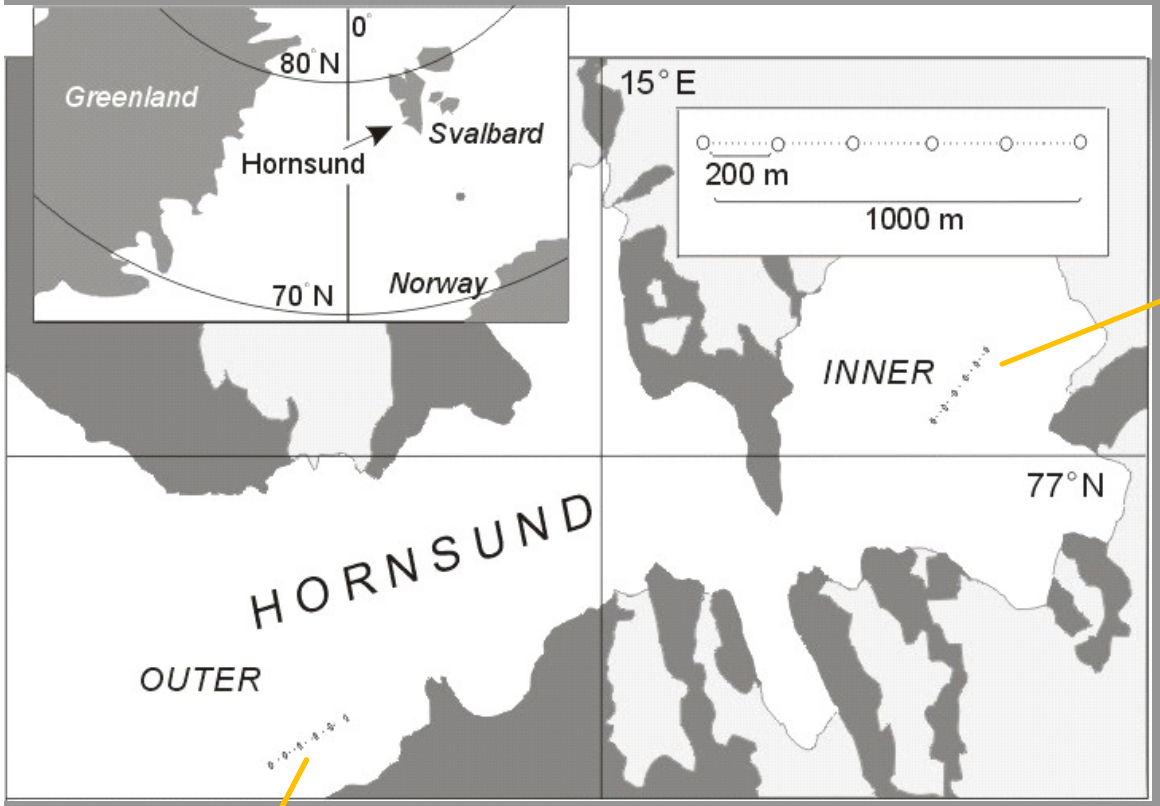
Fig. 12. Macrobenthos biomass distribution in the surface sediments of Hornsund, measured in August 1984 and July 1985. Numbers in circles indicate profiles illustrated as bar diagrams in Fig. 13. 1. >100 g/m², 2. 10–100 g/m², 3. 1–10 g/m², 4. <1 g/m².

Glaciers create the same stress on soft bottom benthos that was described by Pearson-Rosenberg model for contaminated sediments-

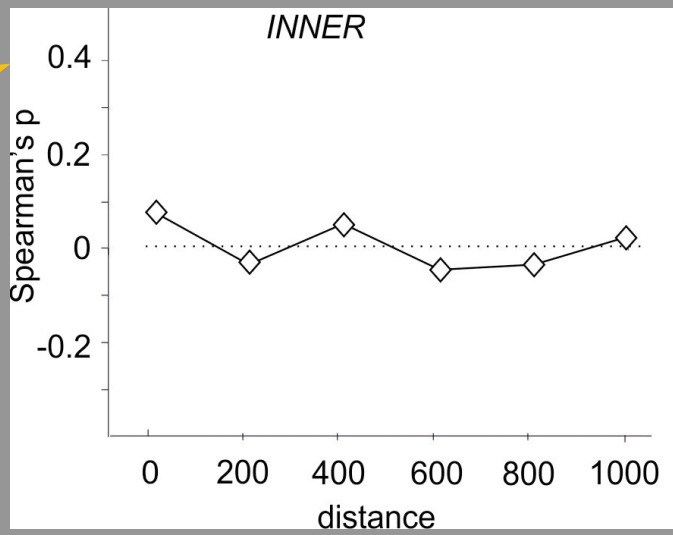
(Włodarska- Kowalczuk & Pearson 2000.)



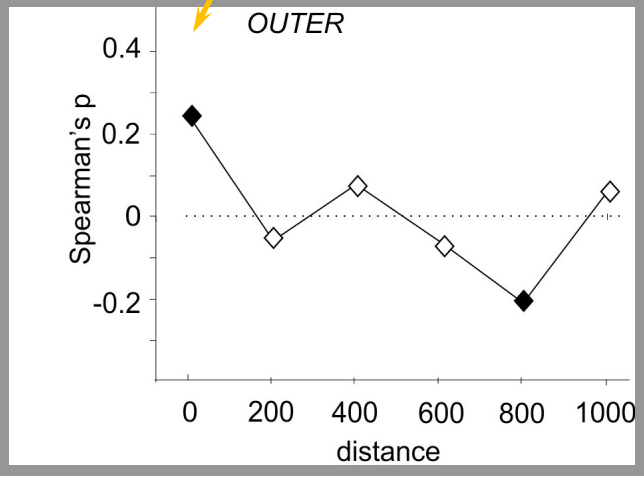
small scale spatial variability of species distribution



correlogram of Bray-Curtis similarity of presence/absence data



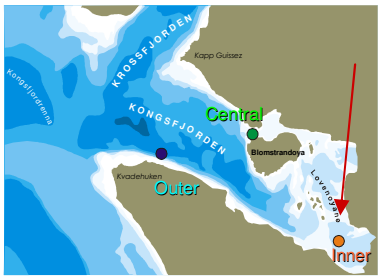
homogenous distribution of species



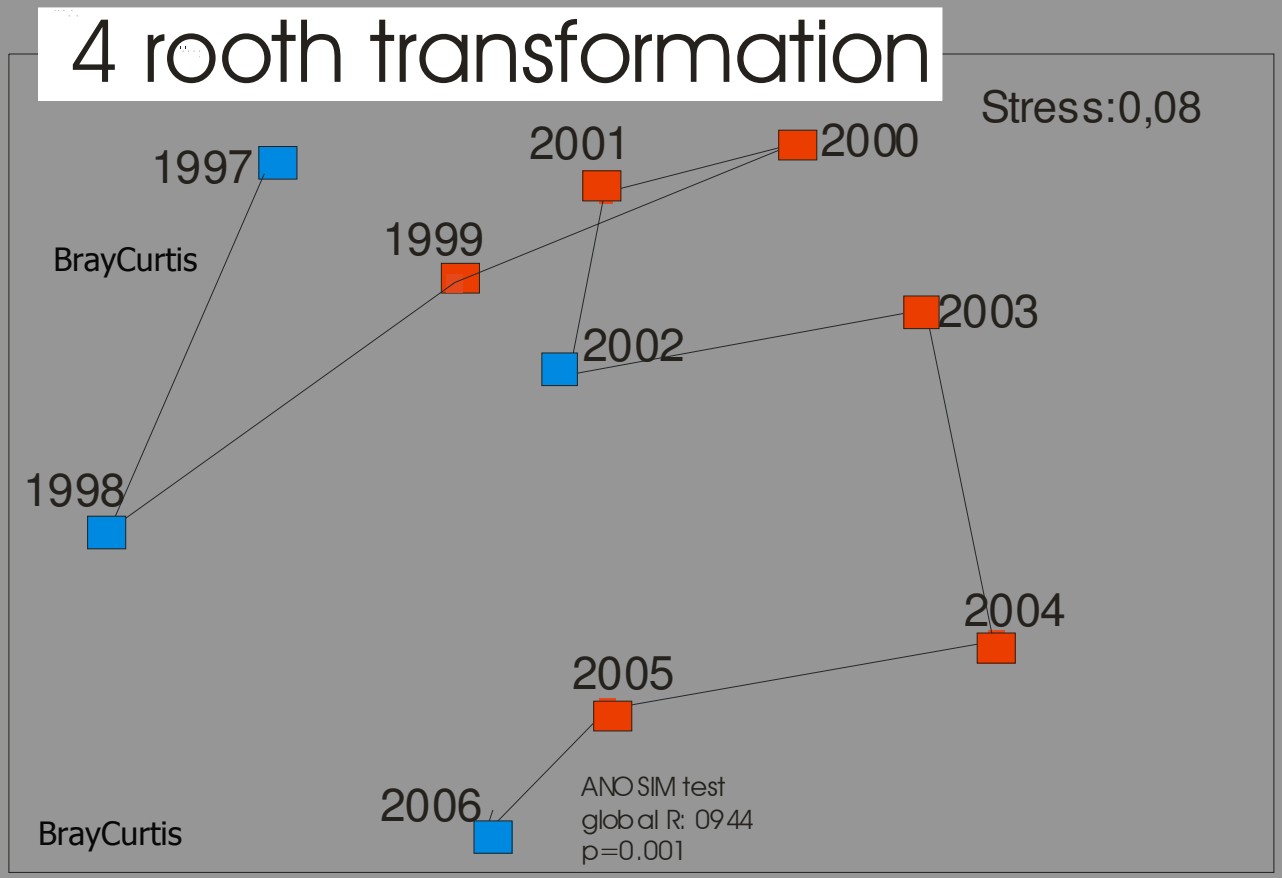
800 m patches of similar species composition

Włodarska-Kowalczuk & Weslawski, MEPS, 2008

Glacier bay benthos - may be boring, but changeable



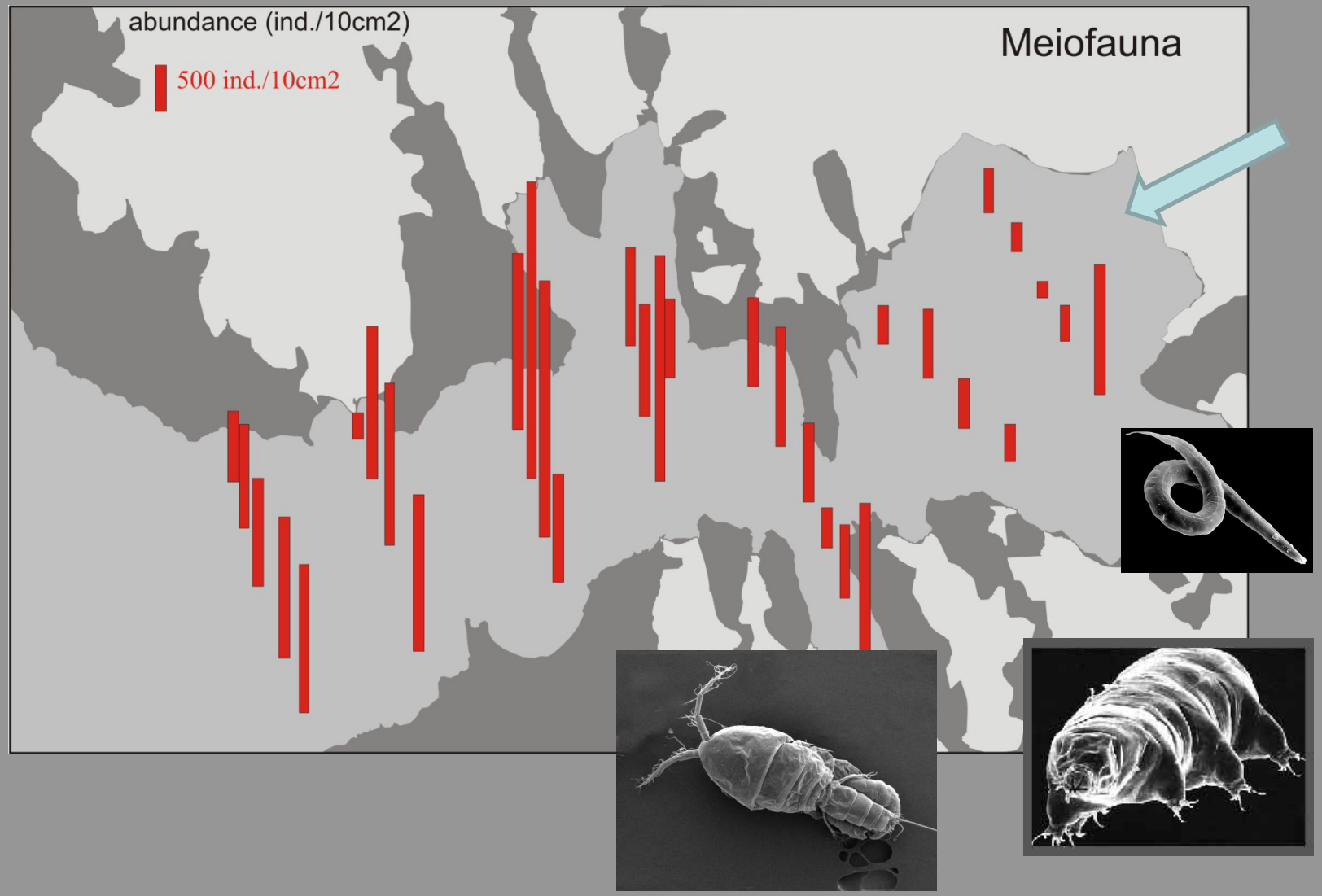
Soft bottom fauna assemblages similarity at near glacier station



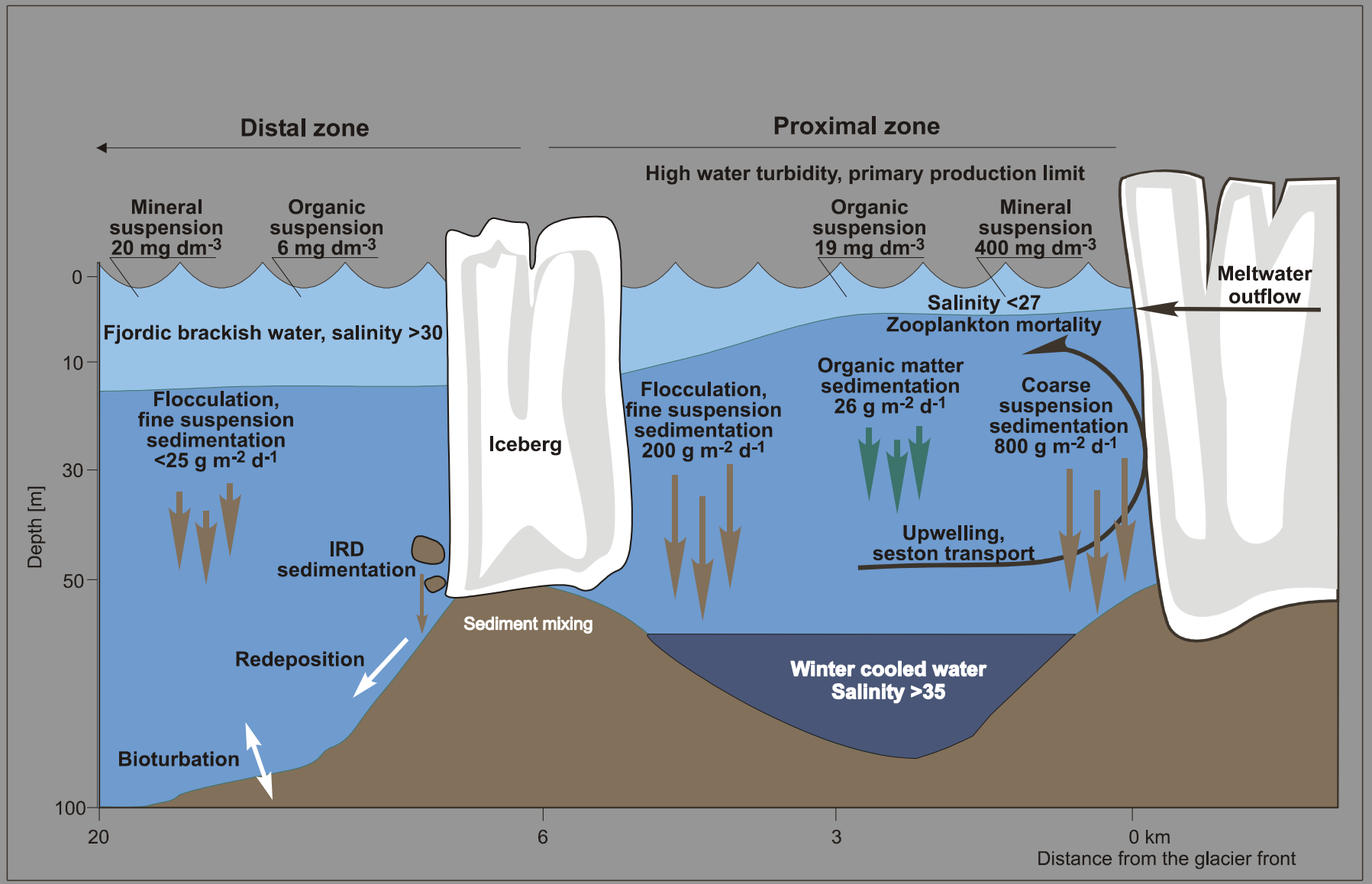
Kędra 2009

Meiofauna density – Hornsund,

Grzelak & Kotwicki 2011

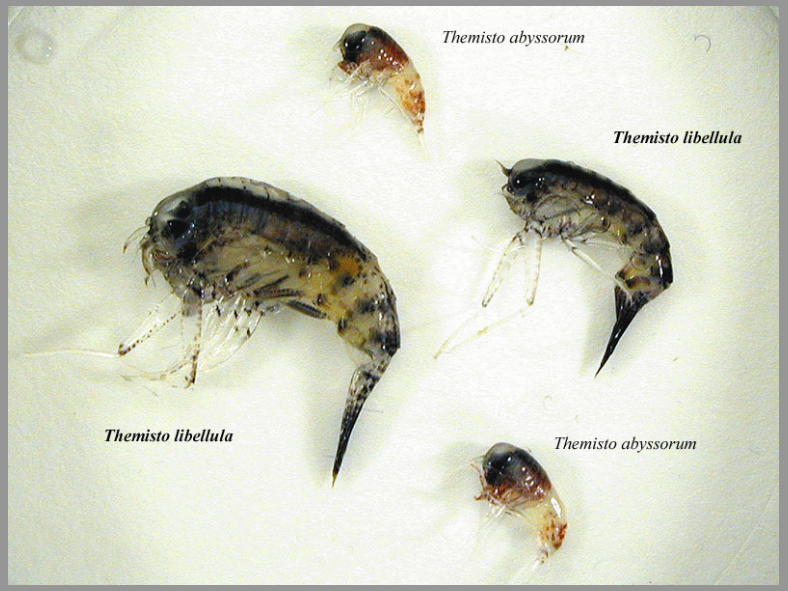


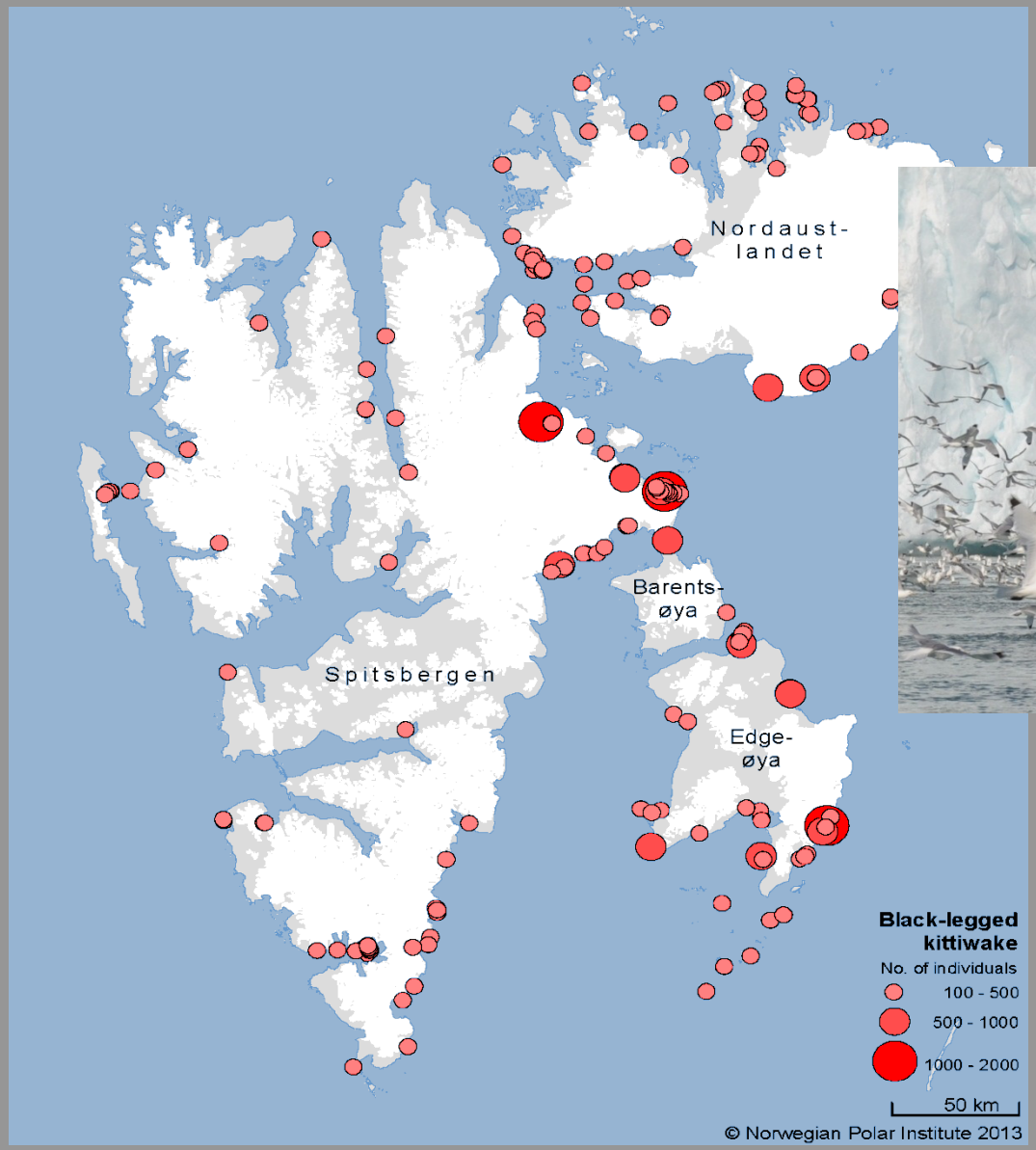
Processes


Distal zone
Proximal zone
High water turbidity, primary production limit
Mineral suspension 20 mg dm-3
Organic suspension 6 mg dm-3
Organic suspension 19 mg dm-3
Mineral suspension 400 mg dm-3
Meltwater outflow
Salinity <27
Zooplankton mortality
Fjordic brackish water, salinity >30
Flocculation, fine suspension sedimentation <25 g m-2 d-1
Iceberg
Flocculation, fine suspension sedimentation 200 g m-2 d-1
Organic matter sedimentation 26 g m-2 d-1
Coarse suspension sedimentation 800 g m-2 d-1
Upwelling, seston transport
IRD sedimentation
Sediment mixing
Redeposition
Winter cooled water Salinity >35
Bioturbation
Depth [m]
0
10
30
50
100
20
6
3
0 km
Distance from the glacier front

Fish & chips

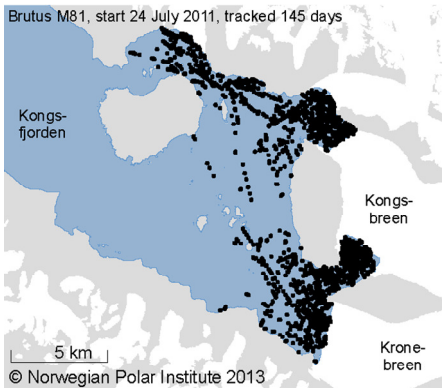

Sheiko

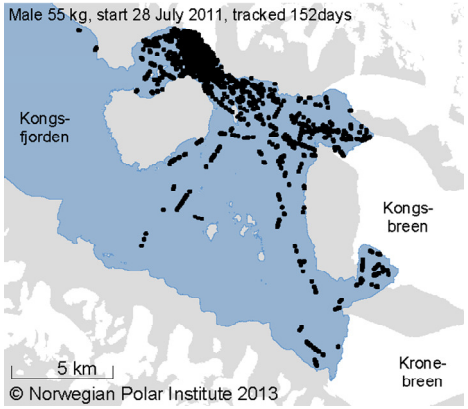

Themisto abyssorum
Themisto libellula
Themisto libellula
Themisto abyssorum

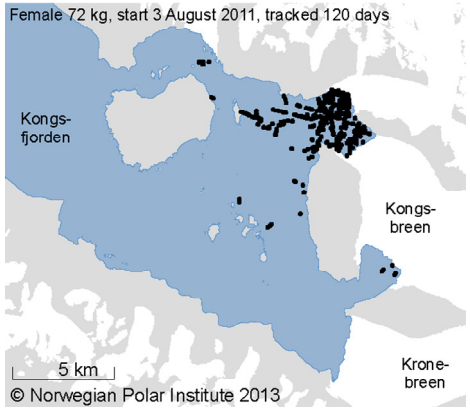


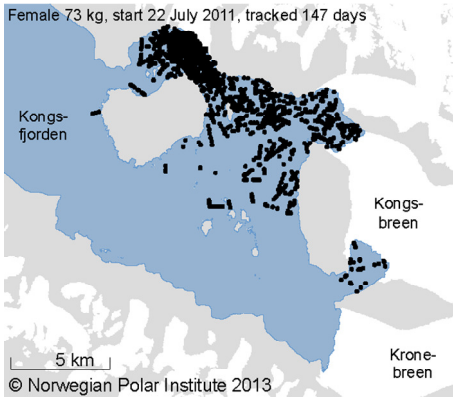
Kittiwakes

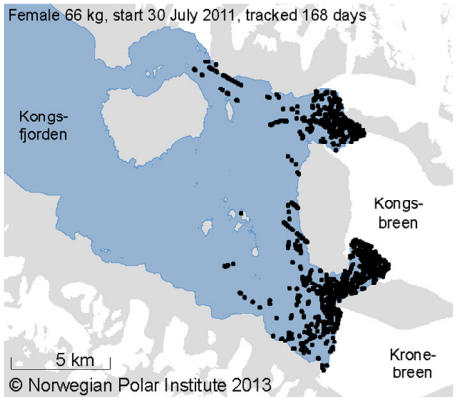
Strom & Steen 2013





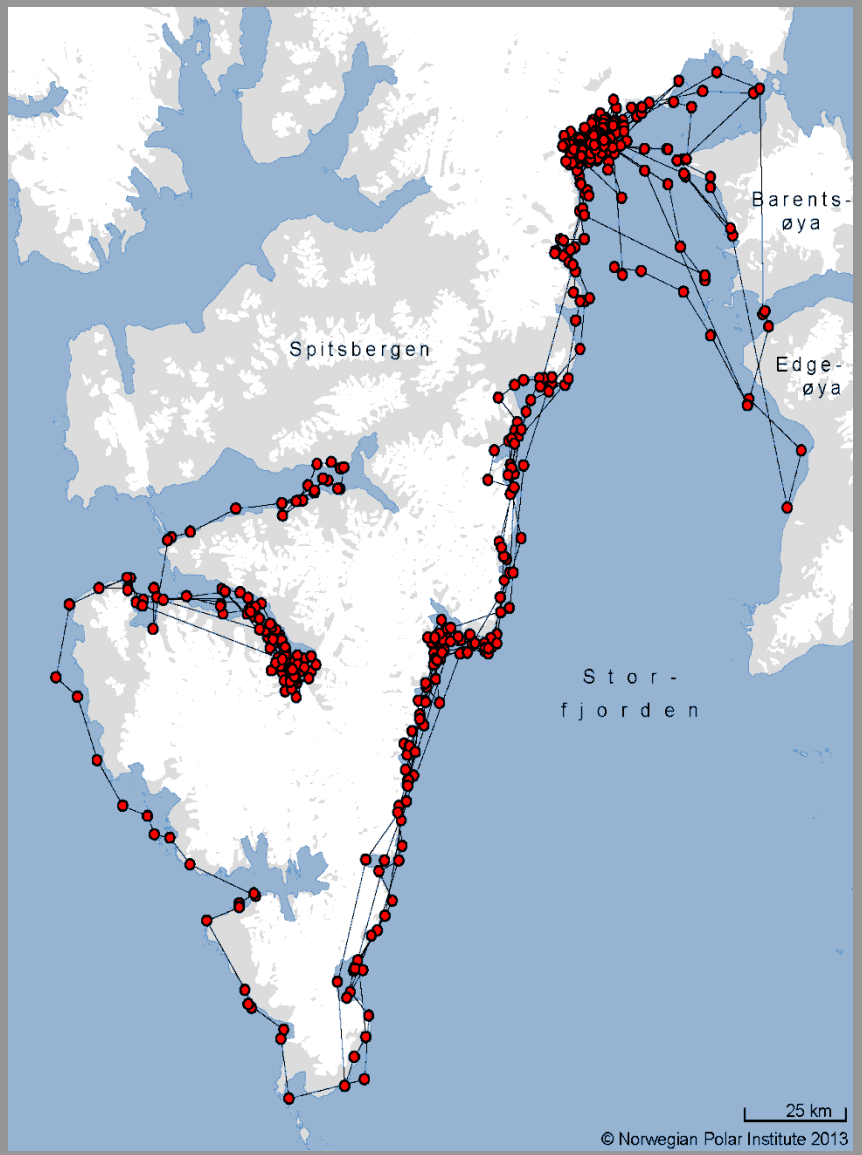






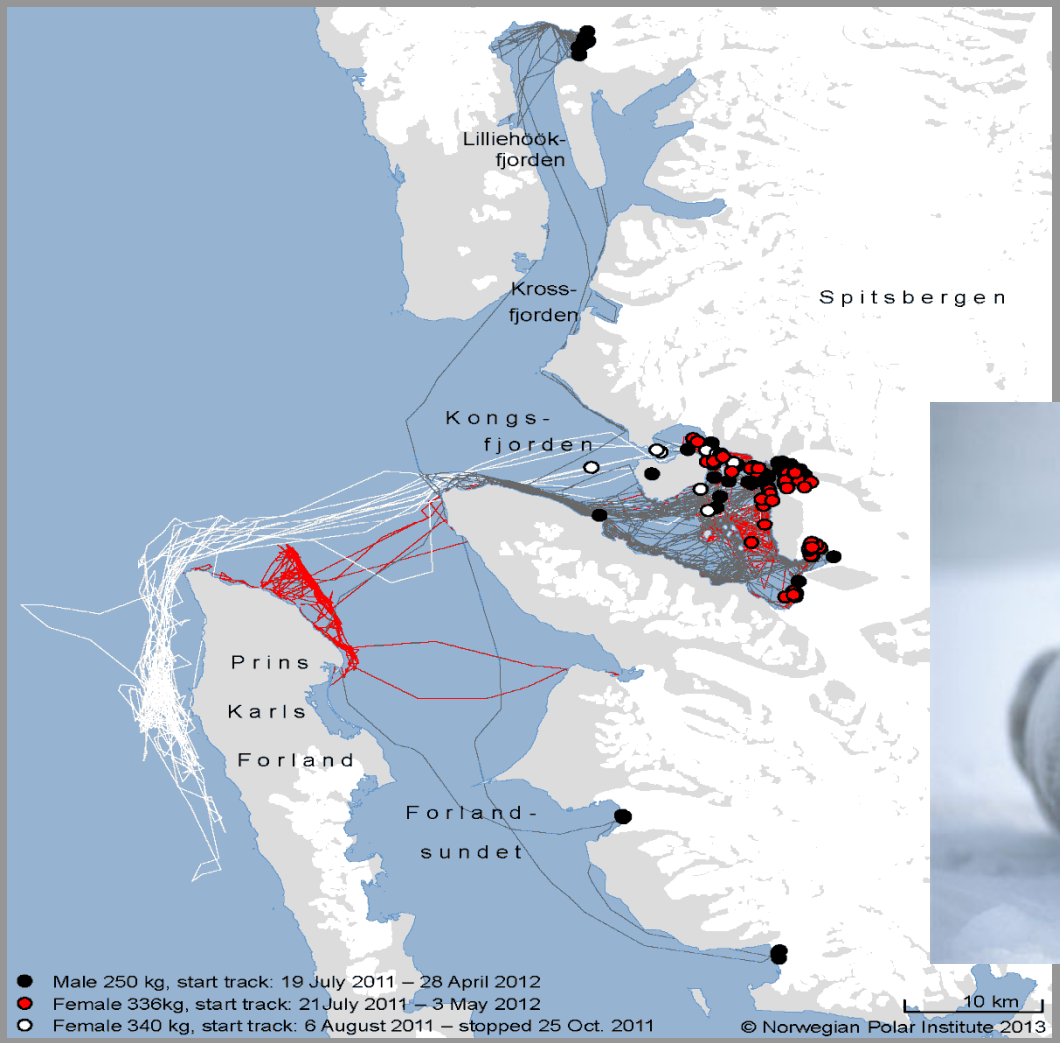
Ringed seals

Lydersen & Kovacs 2013

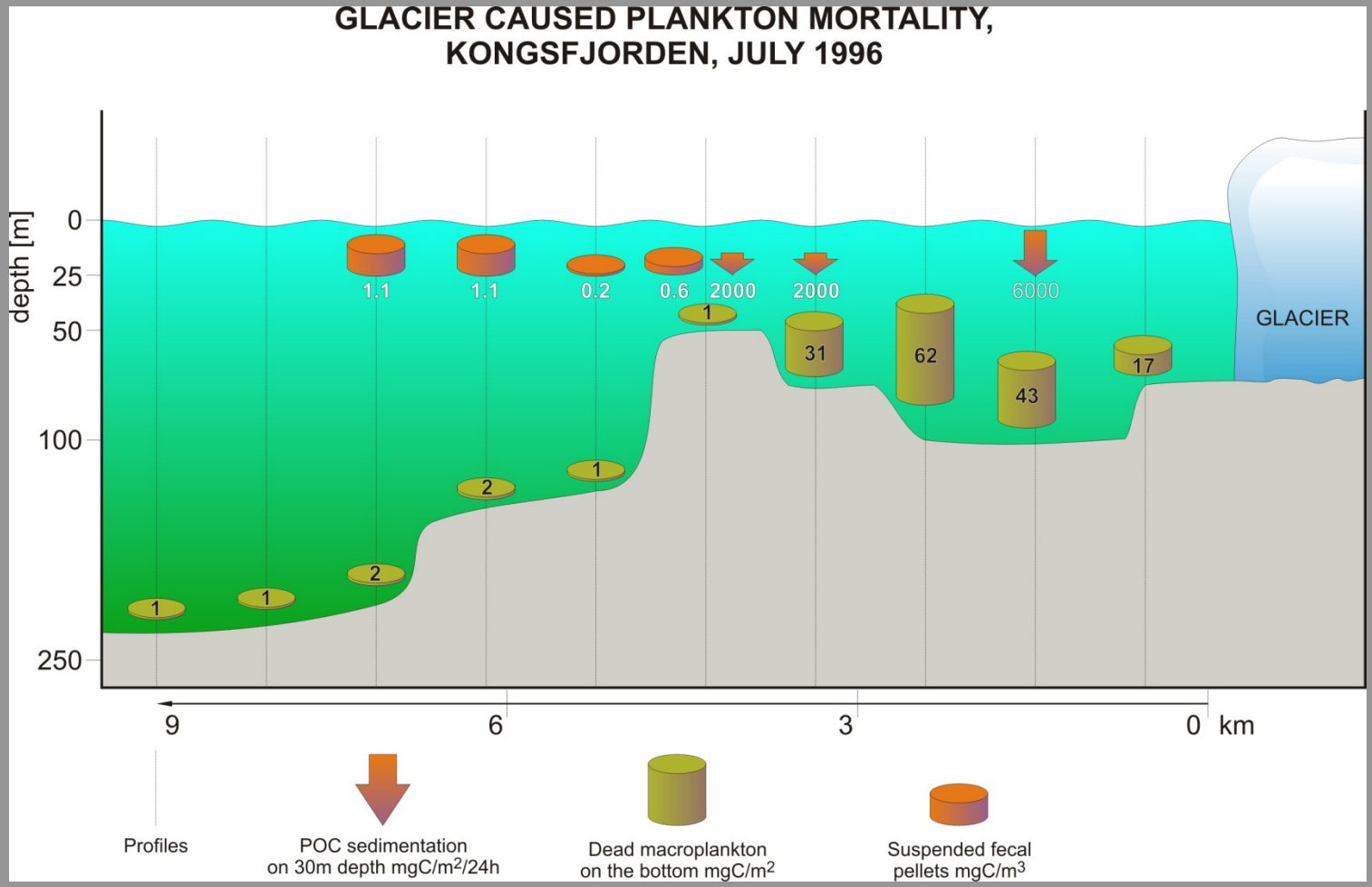


White whale signals

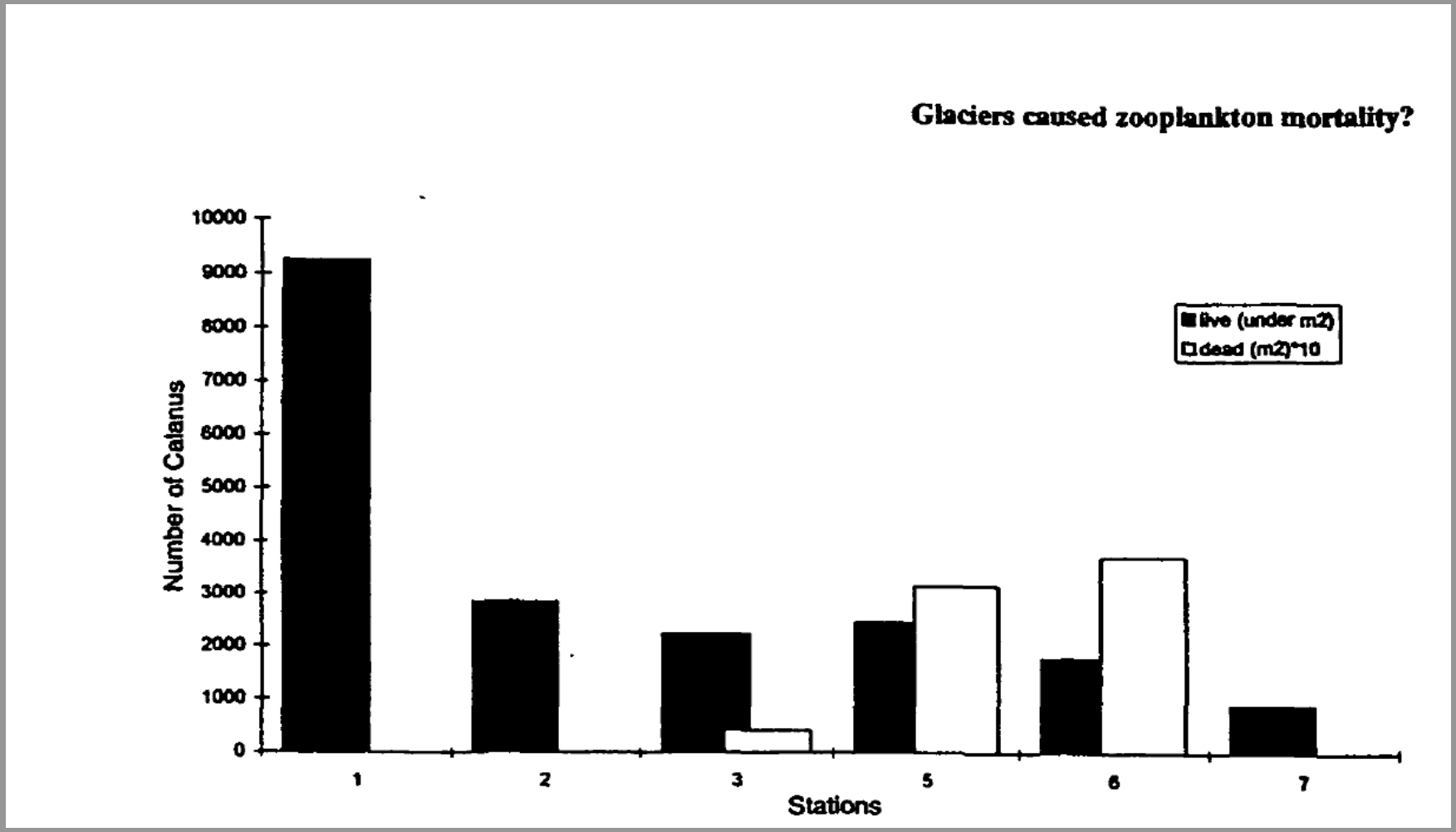
Lydersen & Kovacs 2013



Bearded seals Lydersen & Kovacs 2013


GLACIER CAUSED PLANKTON MORTALITY,
KONGSFJORDEN, JULY 1996
depth [m]
0
25
50
100
250
1.1
1.1
0.2
0.6
2000
2000
6000
1
31
62
43
17
2
1
2
1
1
GLACIER
9
6
3
0
km
Profiles
POC sedimentation
on 30m depth mgC/m2/24h
Dead macroplankton
on the bottom mgC/m2
Suspended fecal
pellets mgC/m3

Dead plankton biomass estimated as 10% in Hornsund
(Weslawski & Legeżyńska 1998)
and 15% in Kongsfjorden (Zajączkowski & Legeżyńska 2001)
of the fjords zooplankton standing stock



24 PSU as critical salinity level to survive for most marine plankters

Higher proportion of *C. finmarchicus & Themisto libellula*
among cadavers, compared to the water column

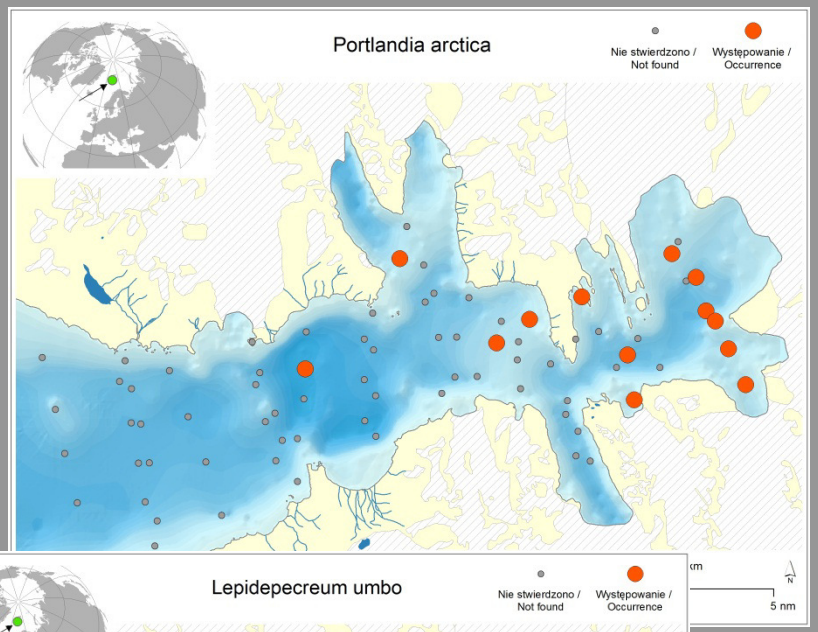
Absence of neritic, brackish water species (*Pseudocalanus*)

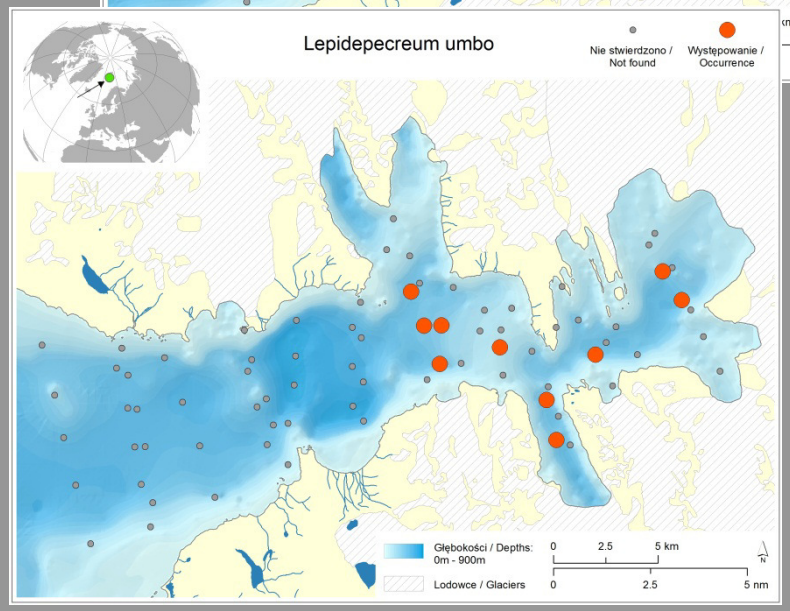
Węsławski & Legeżyńska 1998

***Onisimus caricus*, carrion feeder specialised in feeding on sinking plankton. Up to 20.000 specimens per 6h in baited trap in glacial bay of Kongsfjorden**,

(Zajączkowski & Legeżyńska 2001)

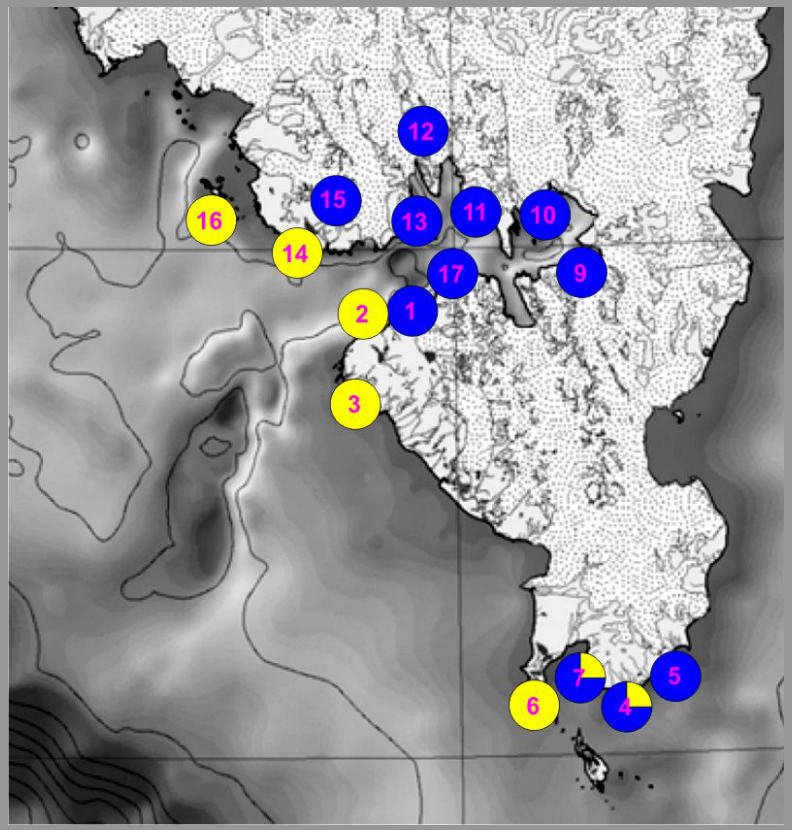
Retreat to the cold waters - deep



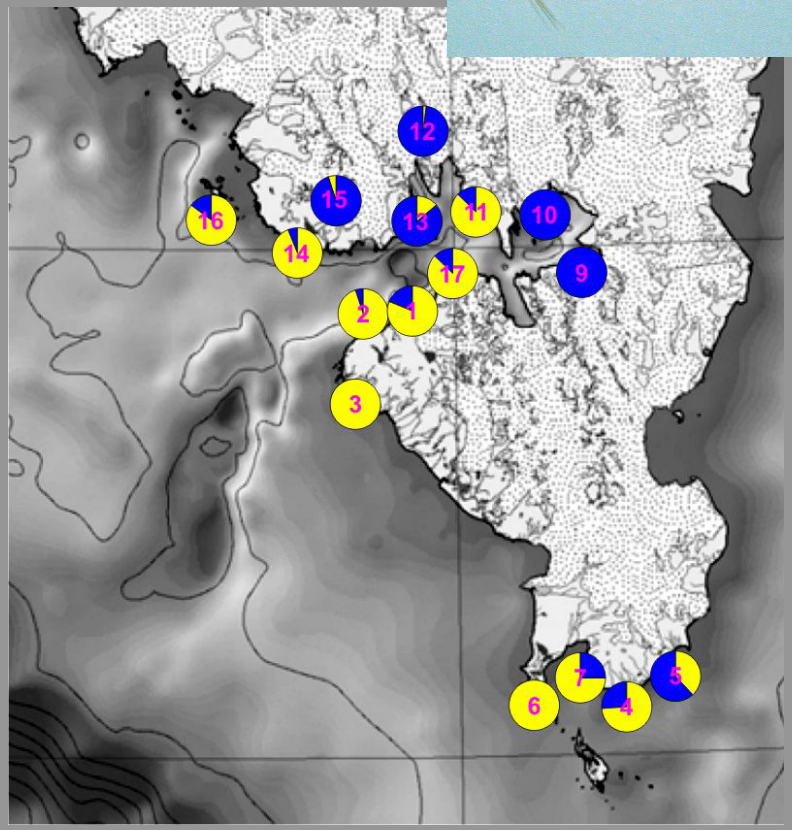


Retreat to cold water - shallow

1988

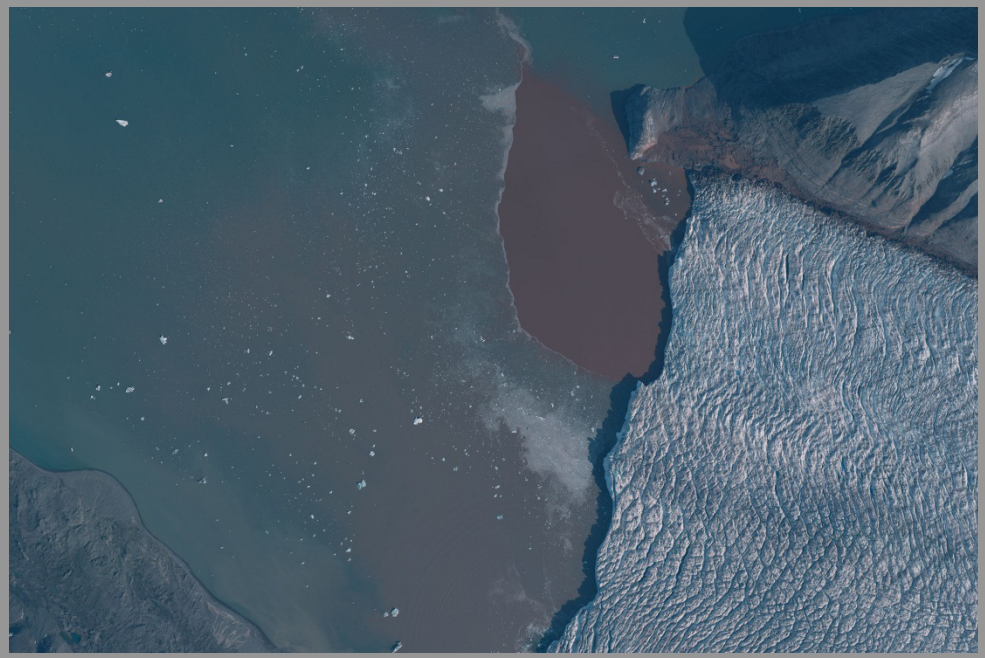


2008

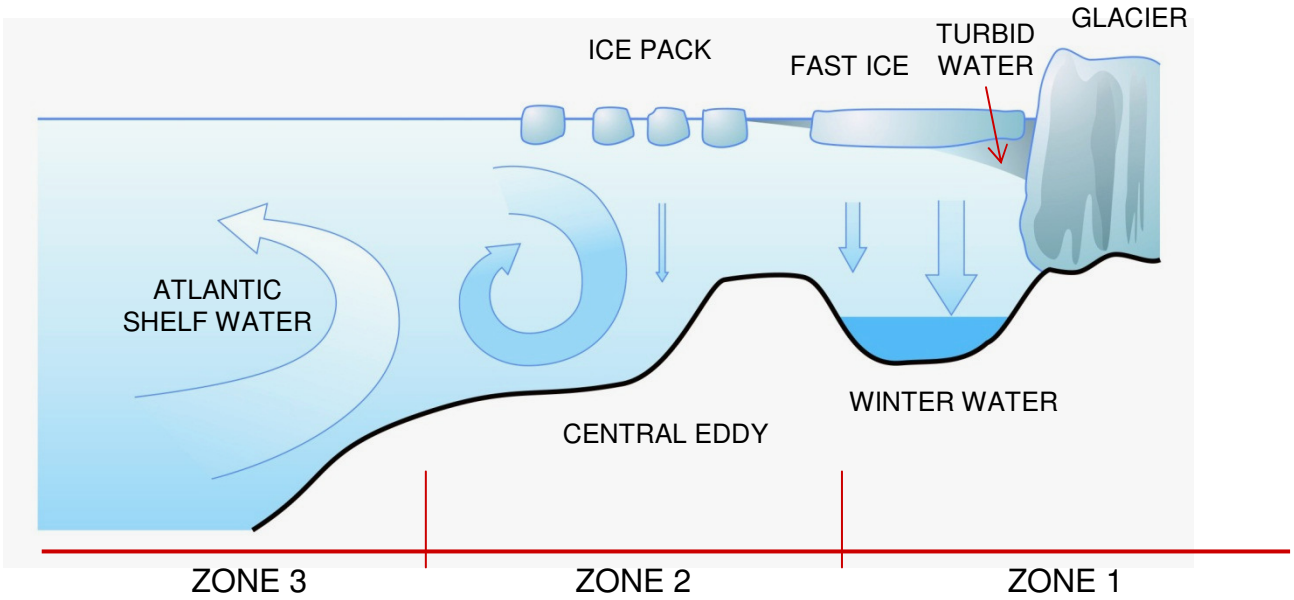


Boreal Gammarus oceanicus and Arctic G. setosus

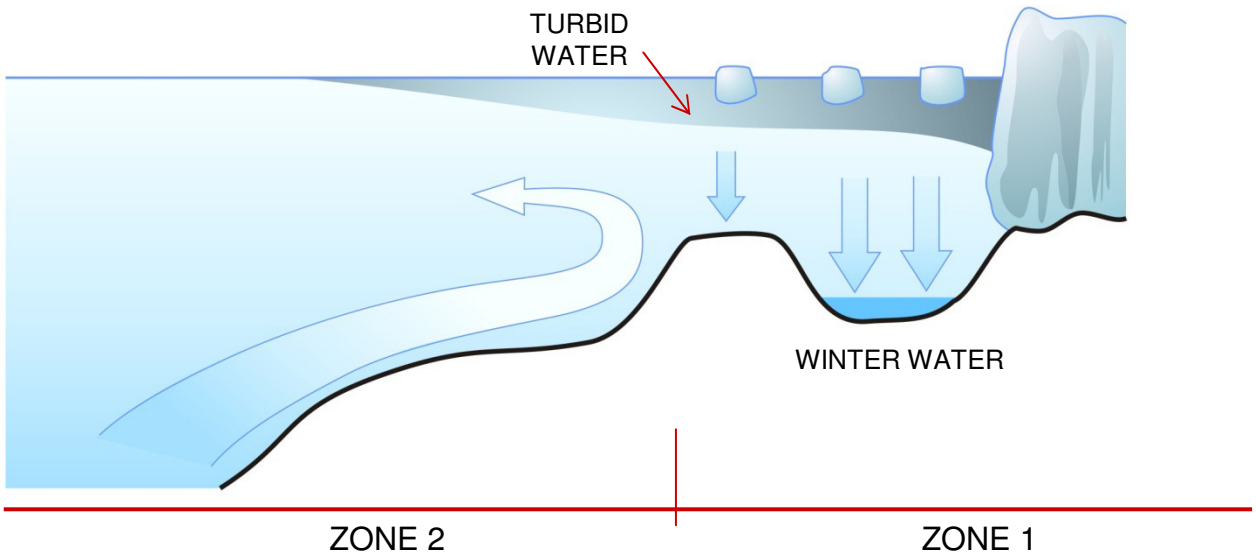
Tidal glacier & glacial river
Are the ecosystem functions the same ?



a


ICE PACK
FAST ICE
TURBID WATER
GLACIER
ATLANTIC SHELF WATER
WINTER WATER
CENTRAL EDDY
ZONE 3
ZONE 2
ZONE 1

b


TURBID WATER
WINTER WATER
ZONE 2
ZONE 1

Changing tidal glaciers to land locked ?

Extensive tidal flats
Reduced sedimentation of coarse material
Increased turbidity ?
Loss of cooled, dense water formation ?


Thank you